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The role of MRI in the diagnosis and management of tracheal diverticulum

Yuan Zhang^{*} , Yiqing Tan, Jing Chen and Cui Fang

Abstract

Background: Multidetector CT is currently the best imaging method for detecting tracheal diverticulum (TD). Compared with CT, MRI is radiation-free and has higher resolution. However, the MRI characteristics of this disease have not been previously reported. The present retrospective study compared the MR and CT imaging features of TD, aiming to examine the role of MRI in TD diagnosis and management.

Methods: Imaging data were collected in 26 TD patients divided into two groups, including the uninfected and infected groups. The MR and CT imaging features (size/wall/channel) of uninfected patients were compared. The performances of MRI and CT in diagnosing and monitoring therapeutic efficacy in infected TD patients were comparatively assessed.

Results: The uninfected group comprised 25 cases with 25 lesions confirmed by CT, including 23 lesions (92%) detected by MRI, with an average diameter of 8.5 mm (range from 3 to 15 mm). Meanwhile, the average diameter was 7.8 mm as measured by CT (range from 2.8 mm to 14.7 mm). The lesion diameters of the two cases not detected by MRI were 2.3 mm and 2 mm. MRI detected walls of all the 23 lesions (23/23), while CT detected no wall (0/23). CT showed channels in 18 lesions (18/23) versus 3 for MRI (3/23). The infected case presented with a paratracheal abscess; MRI clearly showed a relationship between the abscess and the trachea, while CT could not show the lesion source. MRI also sensitively showed the whole process of lesion absorption.

Conclusions: MRI can be used as a supplementary method for TD diagnosis, providing information about the wall that cannot be obtained by CT. MRI is superior to CT in diagnosing infected TD cases presenting with a paratracheal abscess, and in monitoring therapeutic efficacy in these patients.

Keywords: Tracheal diverticula, Paratracheal air cyst, MRI, CT

Introduction

Paratracheal air cysts are incidental findings on CT examination of the chest and neck [1–4], which are almost always located at the right posterior aspect of the trachea [1, 2]. Several studies have suggested the majority of paratracheal air cysts are tracheal diverticulum (TD) [2, 5, 6], which is a benign condition characterized by one or multiple invaginations of the trachea wall [7]. Their incidence has steadily increased because

of improvements in spatial resolution of multidetector CT and the application of thin-slices [8–10]. At present, multidetector CT is considered the best imaging method for detecting TD [11]. The MRI characteristics of this disease have not been previously reported. Indeed, the role of MRI in diagnosing and managing TD is unclear. However, MRI involves no radiation in contrast to CT, and may have some advantages over CT in managing TD patients and monitoring treatment efficacy in infected patients. Besides, several studies have shown that MRI has an important role in the diagnosis of juxtapapillary diverticulum [12, 13]. For this reason, the current study

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was designed. To our knowledge, no similar article has been previously reported.

Materials and methods

This study was conducted with approval from the Institutional Review Board of our hospital. All procedures in the current study were performed in accordance with the ethical standards of the institutional and national research committees as well as with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from all patients.

From January 2020 to January 2022, all TD cases (236) detected by CT in our hospital were reviewed; among them, only 26 patients underwent MR examination and were enrolled in this study. They included 25 uninfected and 1 infected cases.

All uninfected cases were asymptomatic and detected incidentally. The mean patient age was 43.83 ± 8.48 years (range from 35 to 55 years). 17 patients were female and 8 were male.

The infected case was a 45-year-old woman, presenting with a fever, lower neck pain and swelling, and progressive dysphagia.

Examination

All cases were confirmed by CT, and underwent MRI with a duration of less than 1 week after CT.

CT was performed on a 128-slice CT scanner (Discovery HD-670, General Electric Healthcare, Milwaukee, USA). Scan and reconstruction parameters were: detector collimation, $0.625 \text{ mm} \times 128$; thickness, 0.625 mm ; pitch, 1.0; reconstruction interval, 0.625 mm ; matrix, 1024×1024 ; tube voltage, 120 kV; tube current, 400 mA (Table 1). After scanning, the raw data were transferred to the CT workstation (AW4.5 General Electric Healthcare) to generate axial thin-slice images with a thickness of 0.625 mm as well as MRP images. The infected case was administered nonionic contrast medium (370 mgI/ml ; Ultravist; Berlin, Germany) via the elbow vein with a

double-tube power injector at a flow rate of 3 ml/s and a volume of 2 ml/kg body weight. Scanning was performed in 30 and 60 s before and after contrast injection, respectively.

MRI was performed on a 1.5 T unit (Magnetom Avanto; Siemens Medical Solutions, Erlangen, Germany) with a head and neck coil. Sequences and scan parameters were: axial T1WI (TR, 540 ms; TE, 20 ms; matrix, 320×224 ; FOV, $220 \text{ mm} \times 200 \text{ mm}$), axial T2WI (TR, 3340 ms; TE, 101 ms; matrix, 320×224 ; FOV, $220 \text{ mm} \times 200 \text{ mm}$), axial T2WI with turbo inversion recovery magnitude (T2-TIRM, TR, 4000 ms; TE, 30 ms; matrix, 320×224 ; FOV, $220 \text{ mm} \times 200 \text{ mm}$; TI, 180 ms), coronal T2-TIRM (TR, 4000 ms; TE, 30 ms; matrix, 320×224 ; FOV, $300 \text{ mm} \times 300 \text{ mm}$; TI, 180 ms), with 5-mm thickness and a 1-mm interval (Table 2).

Analytical methods

Two chest radiologists with 10 years of work experience reviewed the MR data to calculate the positivity rate. The examined features, including the diameter, wall, channel and density/signal of each TD lesion, were compared on axial images between the MR and CT groups.

Diameter measured in MRI = [diameter measured in (T1WI + T2WI + T2-Tirm)]/3.

Treatment and review

Conservative treatment (intravenous antibiotic therapy, mucolytic agents, and physiotherapy) was selected for the infected TD patient. MRI was performed on days 2, 4, 7 and 21 of treatment to evaluate its role in the diagnosis and treatment of infected TD. CT was only performed after 21 days of treatment because of radiation.

Results

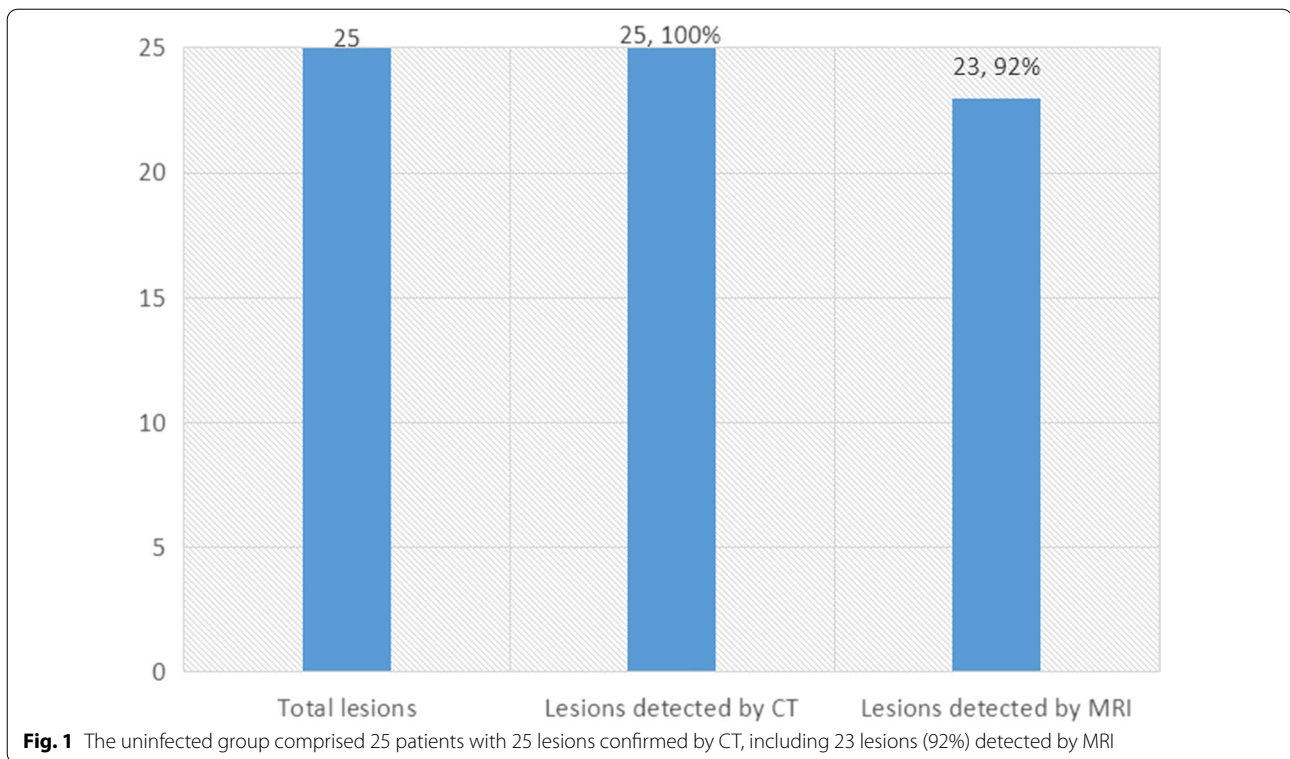
The uninfected group comprised 25 patients with 25 lesions, located on the right side, posterolateral to the trachea between the T1 and T3 vertebrae (confirmed by CT). Of these, 23 lesions were detected by MRI, indicating a positivity rate of 92% (Fig. 1). All lesions

Table 1 Protocol for CT

Parameter	Chest
Detector collimation	128×0.625
Section thickness (mm)	0.625
Section increment (mm)	0.625
Pitch	1
kV	120
mA	400
Image matrix	1024×1024
Scan range	Chest

Table 2 Protocol for MRI

Parameter	Axial T1WI	Axial T2WI	Axial T2-TIRM
TR (ms)	540	3340	4000
TE (ms)	20	101	30
TI (ms)	–	–	180
Matrix	320×224	320×224	320×224
FOV	220×200	220×200	220×200
Thickness (mm)	5	5	5
Interval (mm)	1	1	1



showed an oval or circular air-filled cystic region (air density cyst/no signal area) just behind the right side of the trachea (Fig. 2).

The average diameter of the 23 lesions was 8.5 mm (range from 3 to 15 mm) as measured by MRI vs 7.8 mm (range from 2.8 mm to 14.7 mm) as measured by CT (Table 3). Lesion diameters in the two cases not detected by MRI were 2.3 mm and 2 mm. MRI could detect lesion walls in all cases (iso-intensity in T1WI, and slight hyperintensity in T2WI and T2-TIRM), while CT could not detect them (Fig. 1). CT showed channels between the diverticulum and the trachea in 18 cases (18/23), versus only 3 (3/23) by MRI.

The infected case performed a CT scan 1 year previously because of repeated bronchitis, by which a TD was detected (Fig. 3). Currently, the patient presented a paratracheal abscess. CT revealed a complex air- and fluid-filled mass in the right posterolateral tracheal wall, which had no enhancement after contrast injection (Fig. 4). CT identified no relationship between the abscess and the trachea. Meanwhile, MR imaging clearly showed an abnormal signal mass behind the upper trachea with an irregular and ill-defined margin. The posterolateral wall of the upper trachea was thickened, and the wall signal was high (Fig. 5a), which suggested that the abscess was associated with the trachea.

The patient symptoms gradually relieved, and the lesion showed gradual absorption after conservative treatment. MRI (T2-TIRM sequence) sensitively showed the absorption process of the lesion (Fig. 5b–e).

Discussion

At present, multidetector CT scanning has been shown to be the most effective method for evaluating the presence and features of TD [14]. Characteristic imaging findings include a thin-walled air sac in the paratracheal area with or without communication to the tracheal lumen [1, 7]. The current study showed that MRI had lower capacity in detected the disorder, but could be used as a supplementary method for TD diagnosis. The general MRI finding is an oval or circular air-filled cystic lesion (no signal area) just behind the right side of the trachea in all sequences.

MRI can provide information about the wall of TD which cannot be detected by CT, because it has higher soft tissue resolution. Lesions measured by MRI appear larger than detected by CT, because the diameter measured by MRI is the outer diameter that includes the thickness of the wall, while CT measures the inner diameter. Nevertheless, MRI has reduced ability compared with CT in showing the communication between the air cyst and the trachea. One reason is that the connecting stalk

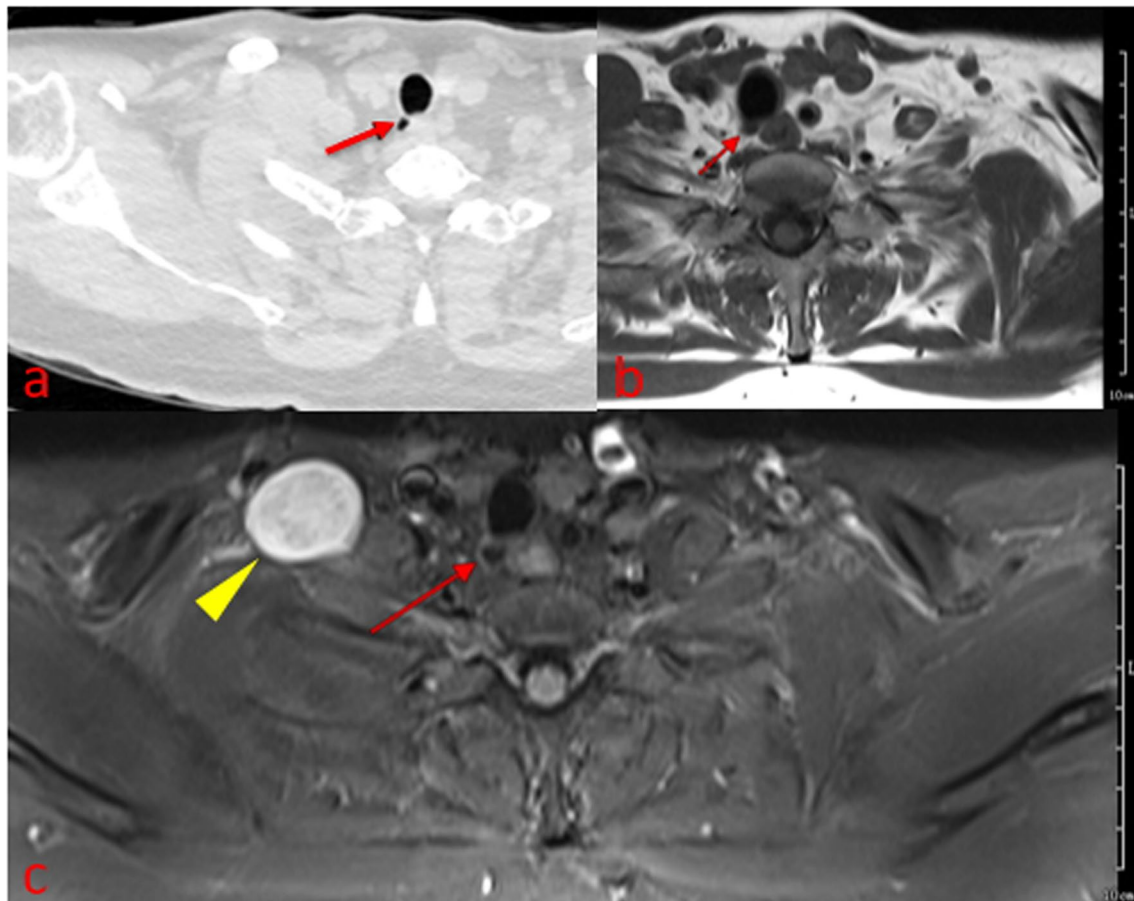


Fig. 2 Axial CT image (a) in lung window showing a 5-mm diverticulum along the right posterolateral wall of the upper trachea (arrow). Axial T1WI (b) and T2-TIRM (c) showed a circular air-filled cystic lesion (no signal area) just behind the right side of the trachea (arrow). T2-Tirm clearly showed the slightly high signal wall of the lesion. Communication between the air cyst and the trachea was not seen in CT or MR images. A schwannoma in the right supraclavicular fossa is shown (arrowhead)

Table 3 Diameter of the TD

Measured by CT (mean, range)	7.8 mm (2.8–14.7 mm)
Measured by MRI (mean, range)	8.5 mm (3–15 mm)

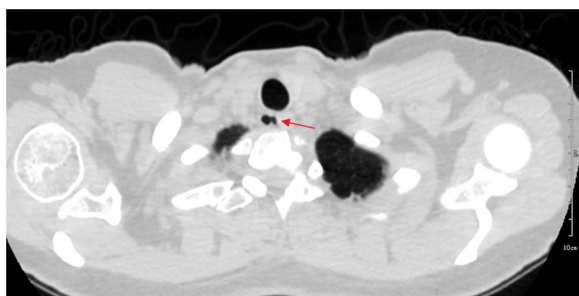
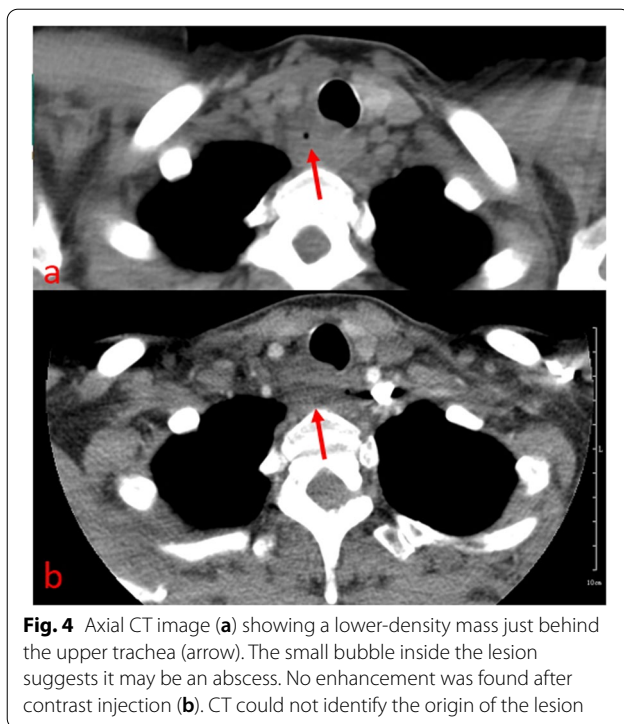


Fig. 3 Axial CT image showing a tracheal diverticulum just behind the upper trachea (arrow)

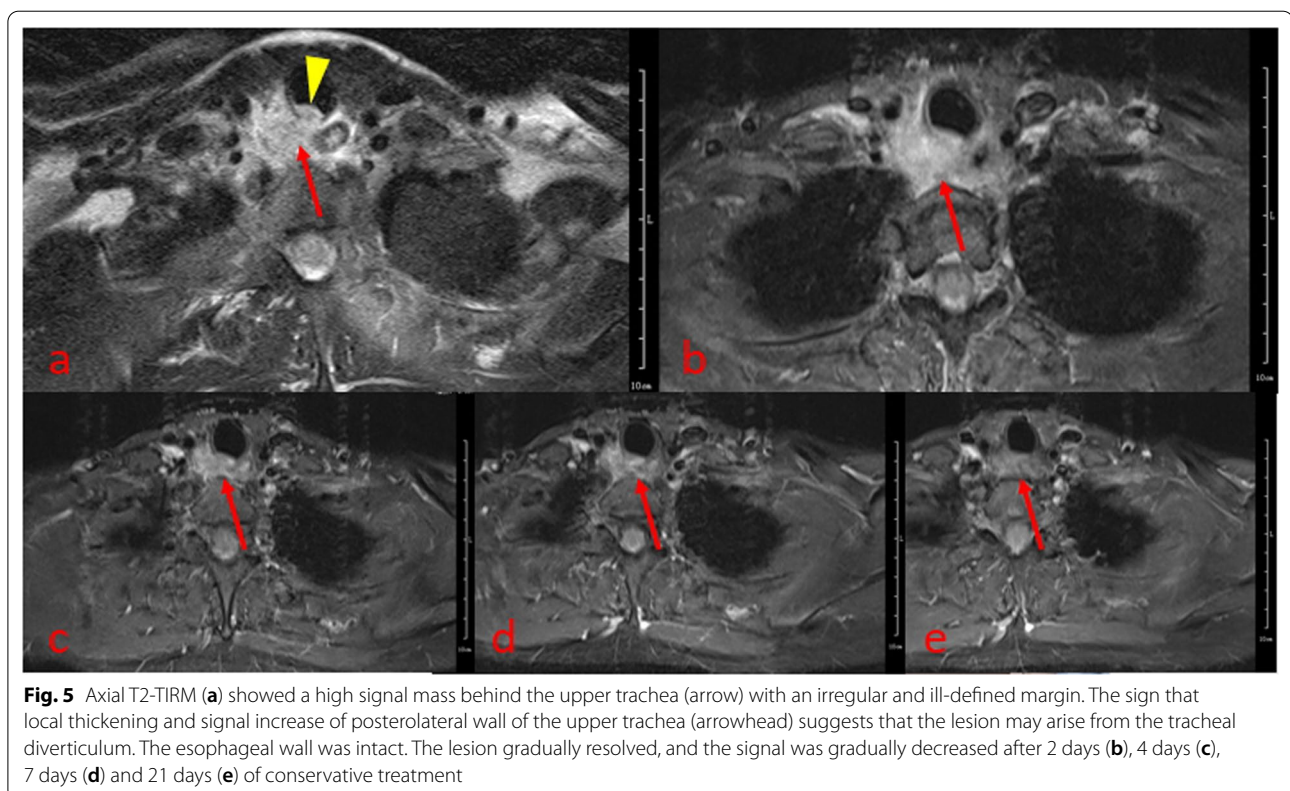
often has a small size, while MR images have thick-slice and wide-intervals; in addition, some cases do not have a visible connecting stalk. Previous studies have shown that the connection between the air cyst and the trachea have different detectable rates between thick-section CT (> 1 mm) and thin-section CT (≤ 1 mm) images, and are detected more frequently with thin-section CT [1, 2, 8–10]. In the future, thin-section CT and three-dimensional MR sequences should be used to display the above connection and to compare the detection rate of thin-section CT.

Identifying the origin of a solitary neck abscess by CT is different, like in our case. On the one hand, the lesion was close to the posterior wall of trachea. On the other hand, the esophagus was partially surrounded by the lesion. In this study, MRI clearly showed a relationship between the abscess and the trachea. These findings indicate MRI is superior to CT in diagnosing infected



TD presenting as a paratracheal abscess. The sign of local thickening and signal increase of the tracheal wall observed by MRI (T2-TIRM sequence) is the key for determining the origin of the lesion. This sign means that infection has spread into the trachea through the thin channel. To our knowledge, infected TD presenting as a paratracheal mass has only been reported in two patients [15, 16]. It is assumed that repeated upper airway inflammation produces mucus in the diverticulum, which then progresses to an abscess [15].

MRI plays an important role in monitoring therapeutic efficacy in infected TD, and should be the first choice in managing such lesions. Most TD cases are asymptomatic and discovered incidentally, not requiring clinical intervention [9, 17, 18]. Both CT and MRI can be used to follow-up these patients. However, in symptomatic patients requiring conservative medical management (antibiotics, mucolytic agents and physiotherapy) and close observation, MRI may be better than CT. Because MRI involves no radiation and has higher soft tissue resolution, it is more suitable for short-term multiple examinations. MRI can sensitively reveal the changes of the lesion, which may help clinicians judge whether the treatment plan is effective, enabling timely adjustment of the medication or treatment plan.



Limitations

There were shortcomings in this study. We only analyzed the role of common MR sequences in diagnosing and managing TD, and special sequences, e.g., like thin-section and three-dimensional sequences, were not included in the study. We did not discuss the relationship between TD and lung diseases (e.g., chronic obstructive pulmonary disease). In addition, the study cohort was small, and a further study is needed.

Conclusion

MRI can be used as a supplementary method for the diagnosis of TD, providing information about the lesion wall that cannot be detected by CT. MRI is superior to CT in diagnosing infected TD presenting as a paratracheal abscess, as well as monitoring therapeutic efficacy in infected TD.

Abbreviations

TD: Tracheal diverticulum; MR: Magnetic resonance; MRI: Magnetic resonance imaging; CT: Computed tomography; T2-TIRM: T2WI with turbo inversion recovery magnitude.

Acknowledgements

Not applicable.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by YZ, YT, JC and CF. The first draft of the manuscript was written by YZ and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding

This work was supported by the Wuhan City Health and Family Planning Scientific Research Project [Grant Number WX20D32].

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in the study were in accordance with the ethical standards of the institutional and national research committees and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient. All experimental protocols were approved by Wuhan Third Hospital (Tongren Hospital of Wuhan University).

Consent for publication

Consents for publication were obtained from all patients.

Competing interests

The authors declare that they have no competing interests.

Received: 18 February 2022 Accepted: 18 April 2022

Published online: 22 April 2022

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